

Report for 2003NE41B: Biodegradation of Dual-Contaminant Mixtures in Groundwater: Chlorinated Solvents and High Explosives

- Articles in Refereed Scientific Journals:
 - Young, T.S.M.; Morley, M.C.; Snow, D.D. “Simultaneous biodegradation of trichloroethylene and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX),” tentatively accepted for publication in ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management; revised manuscript submitted May 2005.
- Dissertations:
 - Young, Travis S.M., 2004, Anaerobic Biodegradation of Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX) and Trichloroethylene (TCE): Single- And Dual-Contaminant Batch Tests, MS Thesis, Environmental Engineering, College of Engineering and Technology, University of Nebraska Lincoln, Lincoln, NE, 140 pages.

Report Follows

Title: Biodegradation to Dual-Contaminant Mixtures in Groundwater: Chlorinated Solvents and High Explosives

Project Number: 2003NE41B

Start Date: April 1, 2003

End Date: December 31, 2004

Funding Source: 104B

Research Category: Water Quality

Focus Categories: GW, TS, TRT

Descriptors: groundwater, remediation, high explosives, chlorinated solvents, biodegradation

Primary PI: Matthew C. Morley

Other PIs: Daniel D. Snow

Project Class: Research

RESEARCH: Due to its extensive use as an explosive, hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) is a common groundwater contaminant at many defense-related sites. Because of its wide spread use as an industrial degreasing compound, roughly fifty percent of the sites listed on the U.S. EPA National Priority List have groundwater contaminated with trichloroethylene (TCE). There are at least five sites in the U.S. that have groundwater contaminated with mixtures of high explosives and TCE. The current remediation approach is to extract this contaminated groundwater and treat it using granular activated carbon, which will be a long and costly process. Single contaminant biodegradation of TCE and RDX has been well studied and can be an effective treatment method. However, there has been no previous research examining the ability of mixed microbial consortia to biodegrade two contaminant mixtures of TCE and RDX. The intent of this research was to make an initial assessment of the feasibility of biodegrading aqueous mixtures of RDX and TCE under anaerobic conditions in laboratory microcosms. The major objectives of this research were to assess the ability of two different microbial consortia to biodegrade TCE and RDX as single contaminants and as mixtures under anaerobic conditions, and to determine the metabolites produced by each culture.

This research examined the ability of two microbial cultures (anaerobic sludge and a facultative enrichment culture) to biodegrade single- and dual-contaminant mixtures of trichloroethene (TCE) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) under anaerobic conditions, using acetate as an electron donor and carbon source. In single component batch tests, both cultures degraded 0.6 – 1 mg RDX/L and its nitroso metabolites to below detection limits in <7 d. During initial 9-d TCE biodegradation tests, the anaerobic sludge did not transform TCE, whereas the facultative culture transformed approximately 10% of the initial 1.4 mg TCE/L. Prior to dual-contaminant batch tests, both cultures were grown in the presence of

TCE. Subsequently, both acclimated cultures rapidly biodegraded mixtures of RDX and TCE. Both cultures degraded RDX and RDX-nitroso compounds to below detection limits in <4 d. In the same tests, TCE-acclimated anaerobic sludge converted TCE primarily to *cis*-dichloroethene (*cis*-DCE), while the acclimated facultative culture produced *cis*-DCE and other chlorinated metabolites. These preliminary results demonstrate that anaerobic bioremediation may be part of a feasible groundwater remediation alternative for mixtures of TCE and RDX.

PUBLICATIONS:

1. Articles in Refereed Scientific Journals:

Young, T.S.M.; Morley, M.C.; Snow, D.D. "Simultaneous biodegradation of trichloroethylene and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)," tentatively accepted for publication in *ASCE Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management*; revised manuscript submitted May 2005.

2. Book Chapter: Not applicable.

3. Dissertations/Theses

Young, Travis S.M., 2004, Anaerobic Biodegradation of Hexahydro-1,3,5-Trinitro-1,3,5-Triazine (RDX) and Trichloroethylene (TCE): Single- And Dual-Contaminant Batch Tests, MS Thesis, Environmental Engineering, College of Engineering and Technology, University of Nebraska Lincoln, Lincoln, NE, 140 pages.

4. Water Resources Research Institute Reports: Not applicable.

5. Conference Proceedings: Not applicable.

6. Other Publications: Not applicable.

D. INFORMATION TRANSFER PROGRAM:

E. STUDENT SUPPORT: 1 MS student (Travis Young) was supported with USGS funding.

F. NIWR-USGS STUDENT INTERNSHIP PROGRAM: Not applicable.

G. NOTABLE ACHIEVEMENTS AND AWARDS: Not applicable.